Aggregation

Aggregate Functions

So far, all SQL expressions have referred to the values in a single row at a time

[expression] as [name], [expression] as [name], ...

select [columns] from [table] where [expression] order by [expression];

An aggregate function in the [columns] clause computes a value from a group of rows

```
create table animals as
  select "dog" as kind, 4 as legs, 20 as weight union
  select "cat"      , 4          , 10            union
  select "ferret"   , 4          , 10            union
  select "parrot"   , 2          , 6             union
  select "penguin"  , 2          , 10            union
  select "t-rex"    , 2          , 12000;

select max(legs) from animals;
```

animals:

kind	legs	weight
dog	4	20
cat	4	10
ferret	4	10
parrot	2	6
penguin	2	10
t-rex	2	12000

max(legs)
4

(Demo)

Mixing Aggregate Functions and Single Values

An aggregate function also selects some row in the table to supply the values of columns that are not aggregated. In the case of max or min, this row is that of the max or min value. Otherwise, it is arbitrary.

```
select max(weight), kind from animals;          select max(legs), kind from animals;

select min(kind), kind from animals;            select avg(weight), kind from animals;
```

(Demo)

```
create table animals as
  select "dog" as kind, 4 as legs, 20 as weight union
  select "cat"        , 4         , 10           union
  select "ferret"     , 4         , 10           union
  select "parrot"     , 2         , 6            union
  select "penguin"    , 2         , 10           union
  select "t-rex"      , 2         , 12000;
```

animals:

kind	legs	weight
dog	4	20
cat	4	10
ferret	4	10
parrot	2	6
penguin	2	10
t-rex	2	12000

Discussion Question

What are all the kinds of animals that have the maximal number of legs?

Groups

Grouping Rows

Rows in a table can be grouped, and aggregation is performed on each group

[expression] as [name], [expression] as [name], ...

select [columns] from [table] group by [expression] having [expression];

The number of groups is the number of unique values of an expression

select legs, max(weight) from animals group by legs;

animals:

kind	legs	weight
dog	4	20
cat	4	10
ferret	4	10
parrot	2	6
penguin	2	10
t-rex	2	12000

legs	max(weight)
4	20
2	12000

legs=4

legs=2

(Demo)

Selecting Groups

Rows in a table can be grouped, and aggregation is performed on each group

[expression] as [name], [expression] as [name], ...

select [columns] from [table] group by [expression] having [expression];

A having clause filters the set of groups that are aggregated

select weight/legs, count(*) from animals group by weight/legs having count(*)>1;

animals:

weight/legs	count(*)
5	2
2	2

weight/legs=5
weight/legs=2
weight/legs=2
weight/legs=3
weight/legs=5
weight/legs=6000

kind	legs	weight
dog	4	20
cat	4	10
ferret	4	10
parrot	2	6
penguin	2	10
t-rex	2	12000

Discussion Question

What's the maximum difference between leg count for two animals with the same weight?

Example: Big Game

(Demo)

Create Table and Drop Table

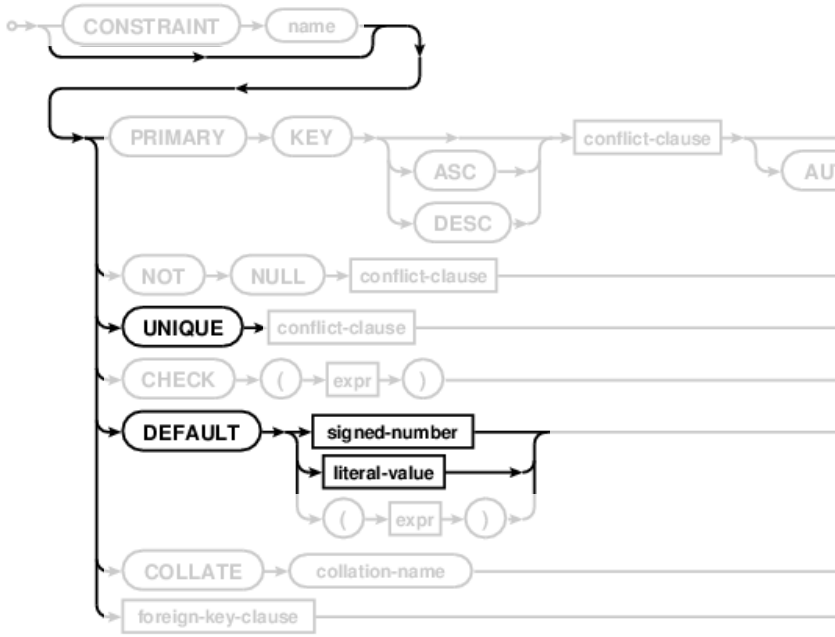# Create Table

CREATE TABLE expression syntax:
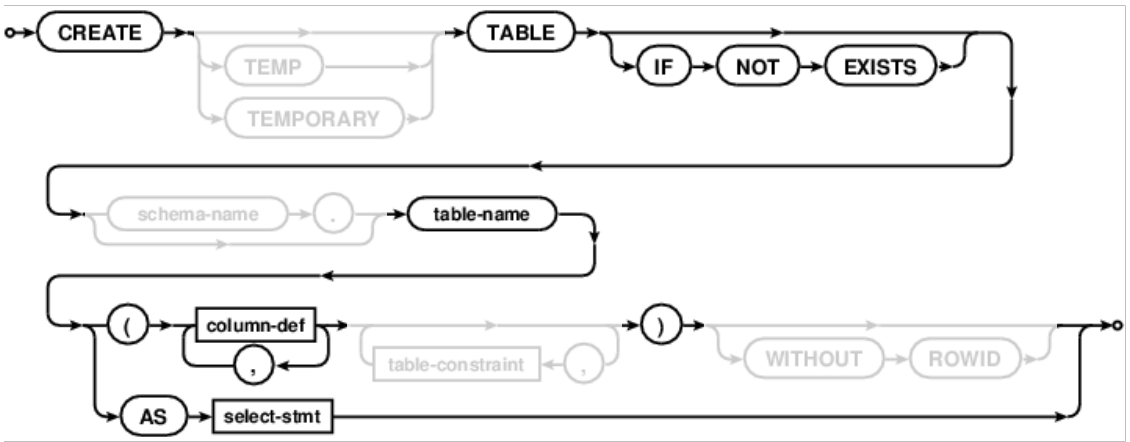
Examples:

```sql
CREATE TABLE numbers (n, note);
CREATE TABLE numbers (n UNIQUE, note);
CREATE TABLE numbers (n, note DEFAULT "No comment");
```
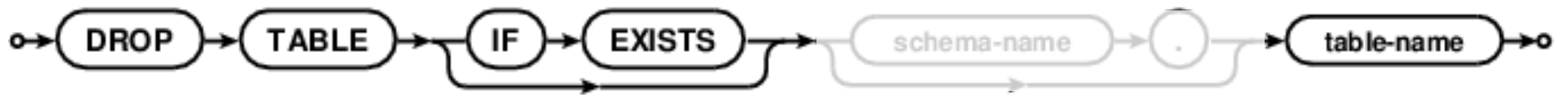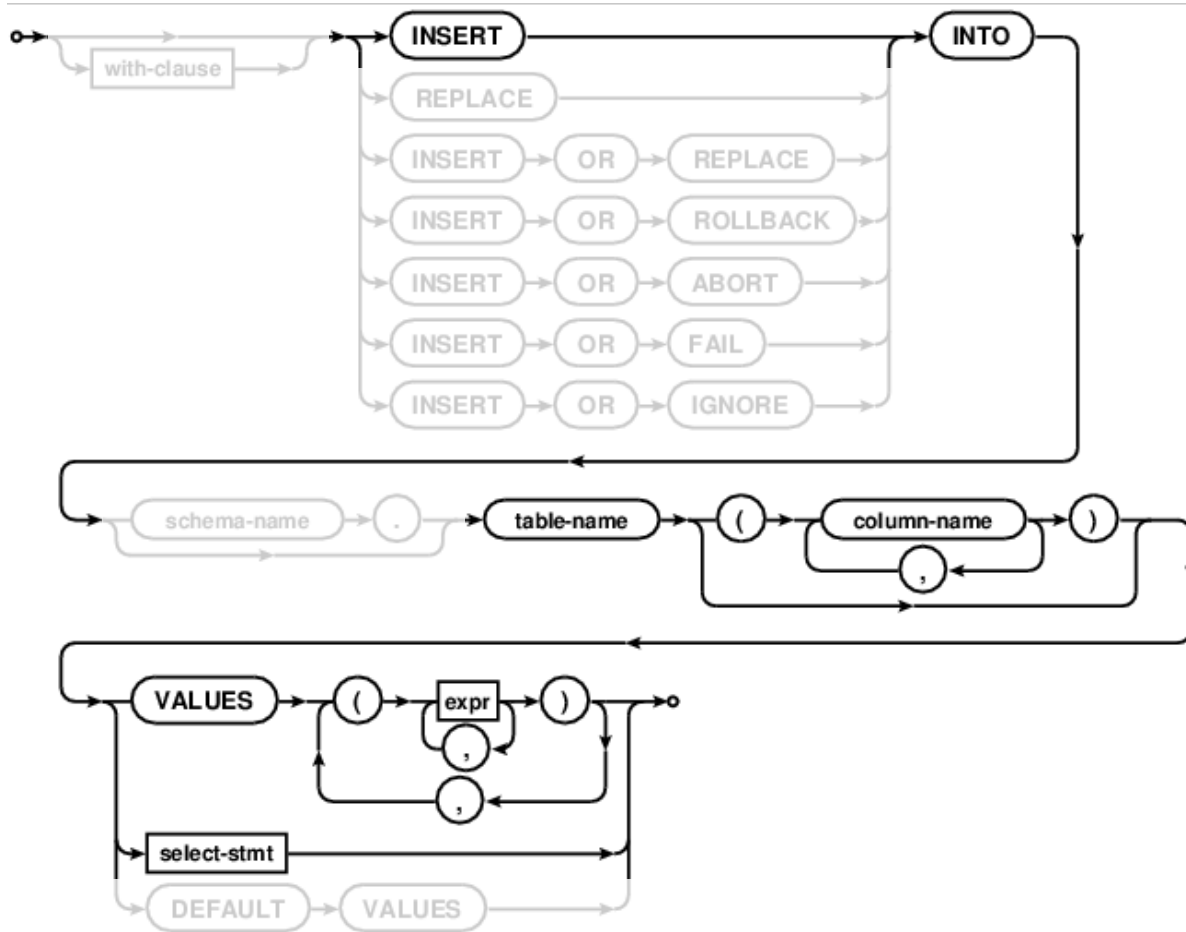
column-def:

column-constraint:

Drop Table

Modifying Tables

Insert

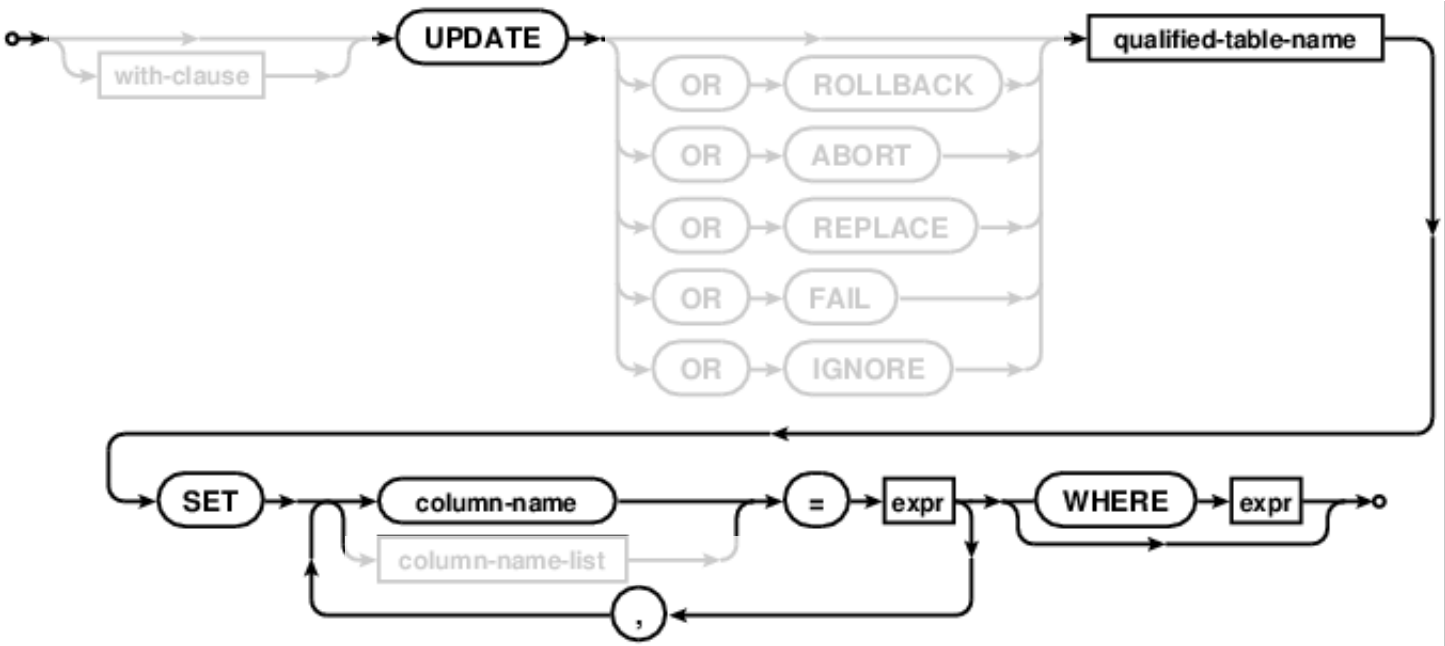For a table t with two columns...

To insert into one column:

INSERT INTO t(column) VALUES (value);

To insert into both columns:

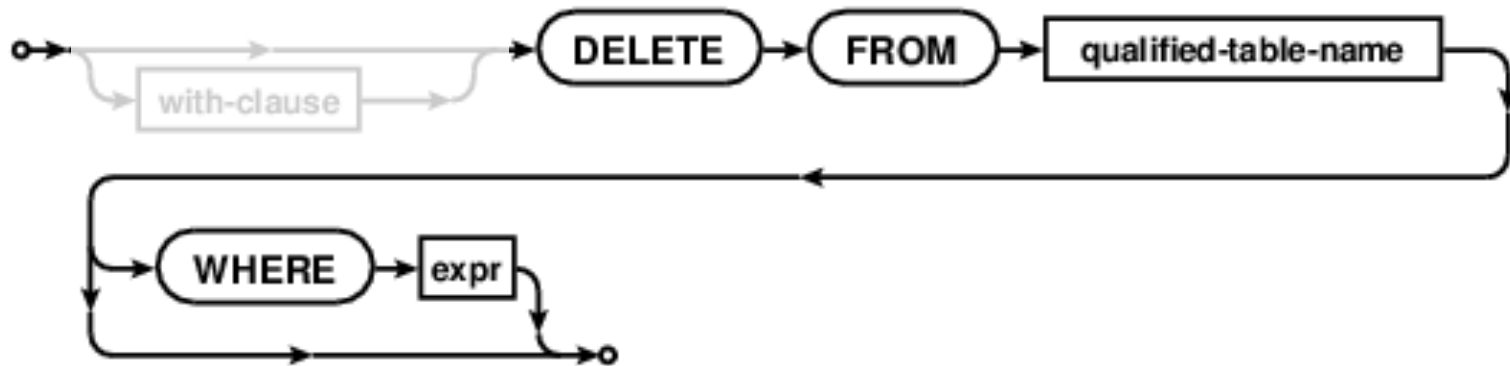**INSERT INTO t VALUES (value0, value1);**

(Demo)

Update

Update sets all entries in certain columns to new values, just for some subset of rows.

(Demo)

Delete

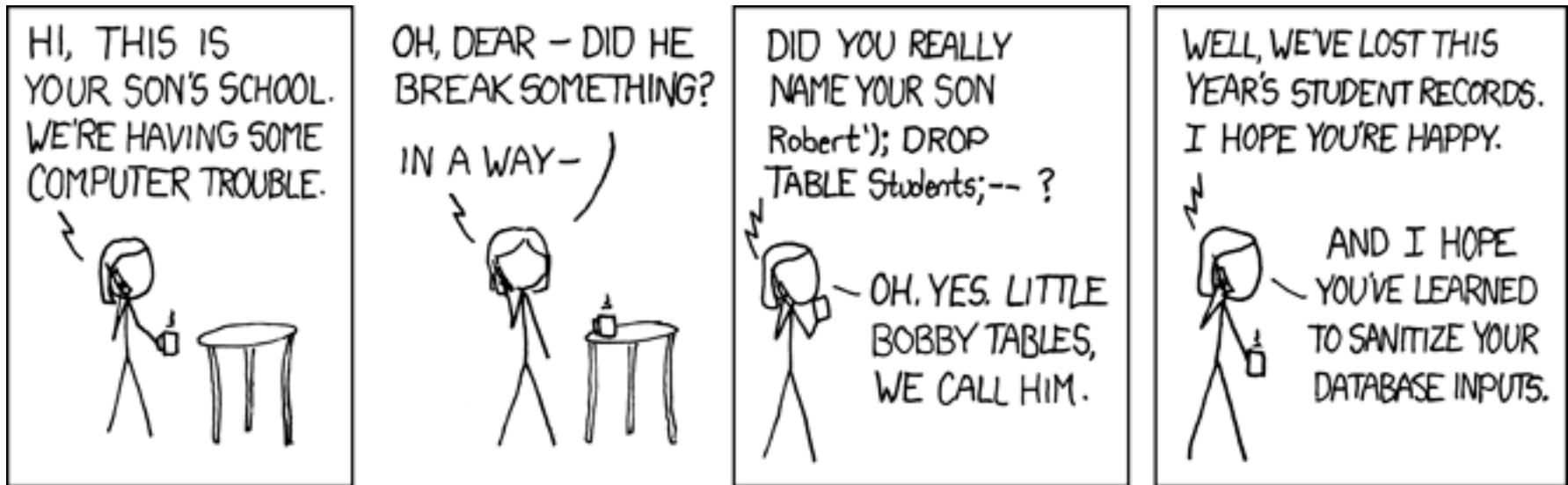Delete removes some or all rows from a table.

(Demo)

Python and SQL

（Demo）

SQL Injection Attack

A Program Vulnerable to a SQL Injection Attack


```
name = "Robert'); DROP TABLE Students; --"
cmd = "INSERT INTO Students VALUES ('" + name + "');"
db.executescript(cmd)    db.execute("INSERT INTO Students VALUES (?)", [name])
```

```
INSERT INTO Students VALUES ('Robert''); DROP TABLE Students; --');
INSERT INTO Students VALUES ('Robert'); DROP TABLE Students;    ');
```
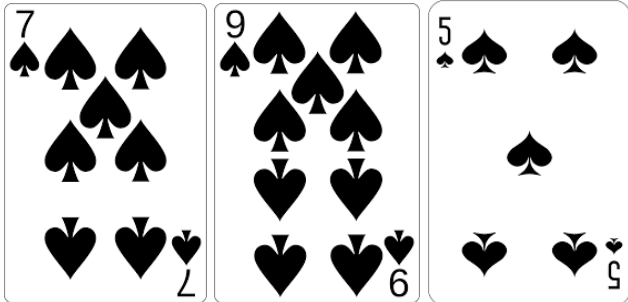
https://xkcd.com/327/

Database Connections

Casino Blackjack

Player:

Dealer:

(Demo)